



Research on Supply Chain Coordination Model Based on Repurchase Contract of Commodity Selling Price Change

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Abstract. Repurchase contract is one of the important contract means to coordinate the supply chain whose market life cycle is relatively short and the selling price of goods will be affected by uncertain demand factors. Supply chain is composed of the circulation and exchange of capital flow, logistics and information flow in the whole chain. In order to strengthen the study of supply chain management and supply chain coordination, we should use computer technology to analyze the supply chain coordination based on repurchase contract after the change of commodity sales price by constructing the supply chain coordination algorithm model, and take corresponding adjustment measures to improve the competitiveness of enterprises.

Keywords: Commodity Sales Price Change · Repurchase Contract · Data Information Processing · Supply Chain Coordination Algorithm Model

1 Introduction

With the increasingly fierce market competition in China and the increasing uncertainty of the market environment, in order to reduce the risks of downstream members of the supply chain to a certain extent. In the short life cycle and the sales price is vulnerable to demand changes affect the sales of goods will often through computer modeling and based on the analysis of the algorithm using the repurchase contract to coordinate the supply chain between upstream and downstream members of risk responsibility, upstream members in commodity sales price declines to set price to buy back its downstream members via the remaining order. This can reduce the risk of downstream members of the supply chain, and play a positive role in maintaining the brand image of upstream enterprises. Therefore, the profit maximization of the supply chain can be achieved objectively. But on the basis of the buy-back contract of supply chain coordination mechanism also has sales cost control, changes in the price of goods sold in different stages, and such problems as information asymmetry, increased the difficulty of the supply chain coordination, so should use the professional computer software by big data analysis and modeling of supply chain coordination under the repurchase contract situation analysis, in order to accurately grasp the relationship between the elements, so as to promote the optimization of supply chain coordination.

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In the actual sale of commodities, prices are often affected by demand changes and other factors [5]. Especially when the goods for a longer period ahead of schedule, and fashion goods sales period is relatively short and the perishable goods, due to its sales process has different stages, in different stages of the sales price will produce significant change, usually sold in the first phase of the commodity prices more normal, but after entering in the late stage of the second sales. Under the common influence of market competition factors, product life cycle factors and product characteristics factors, the sales price will drop. This objectively increases the difficulty of supply chain coordination [1]. In order to accurately grasp the supply chain coordination situation based on the repurchase contract after the commodity sales price drops, a supply chain coordination model should be constructed.

In the construction of repurchase contract model, parameters should be set according to different changes of demand function, so as to analyze and study supply chain coordination under different decision-making strategies [3]. The modeling parameters of the supply chain coordination model under the repurchase contract of commodity sales price changes mainly include demand at different stages (x_i), probability density function $f(x_i)$ of demand at different stages, differentiable cumulative distribution function $F(x_i)$ of demand at different stages, which should be strictly increasing function, and mean value of demand at different stages, etc. At the same time, in the model also involves wholesale price (w), quantity (q), cost (c), the rest of the goods unit the salvage value (v), different stage of sales price (p), unit (g) out of stock cost, at the end of phase I of sales after the inventory (y) and expected profits (π_i), and other related parameters. In setting model parameters, suppliers should be set as rational participants to ensure that $p_1 > p_2$ and $p_1 > w > c > v > 0$. The selling price of commodities in phase I should be higher than that in phase II, and the selling price of commodities in phase I should be higher than wholesale price, production cost and residual value of commodities.

2.1 Centralized Decision Model of Supply Chain Coordination Under Repurchase Contract with Falling Commodity Sales Price

In order to maximize the overall profit of the whole supply chain, the supply chain coordination model should be first constructed under the centralized decision-making strategy, that is, the sellers and suppliers make joint decisions to ensure the optimal order quantity [3]. In modeling, the expected profit function of the sales after the commodity enters phase II should be established first, and then the overall expected profit function of the supply chain should be established based on the sales situation of the commodity in phase I. After that, the derivative of the total expected profit function of the supply chain to the order quantity under the supply chain concentration strategy should be taken, and the derivative should be set to 0. After completing the second derivative of the order quantity under the centralized strategy of supply chain, it can be found that the relationship between the total expected profit of supply chain and the order quantity under the centralized strategy is concave function, and the total expected profit value is the maximum under the condition of the first derivative is 0 [8]. When the goods will be

determined by a centralized strategy two phases of sales, and in phase II the sales prices fall, the sellers will order as a proposition for the analysis, such as in the commodity sales at constant prices to centralized decision-making strategy based on the determined quantity increase your order, according to the function of the model calculation, the relationship between characteristics of $F(x)$ is increasing function, this shows that the use of price reduction for phase II of sales can increase the overall sales of the supply chain. In other words, in the process of commodity sales, if the sales strategy of price reduction is not adopted, the seller will reduce the order quantity of goods in order to hedge the market competition risk and pursue the maximization of their own profits. In the function relation of this model, the only variable of decision is the quantity of order, so supply chain coordination can be realized by controlling the quantity of order in decentralized decision.

2.2 Supply Chain Coordination Decentralized Decision-Making Model Under Wholesale Price Repurchase Contract When Commodity Selling Price Drops

The so-called decentralized decision-making strategy is the decision-making mode adopted by both the seller and the supplier on the basis of only seeking to maximize their own profits, which does not consider whether the maximization of the overall profit of the supply chain can be realized. The commodity supplier will supply the commodity to the seller at the agreed wholesale price (W) based on the wholesale price contract, and the seller will sell the commodity at p_1 and p_2 prices in different sales stages [10]. The quantity of order shall be determined by the seller in accordance with the principle of maximizing its own profits. In order to construct the chain coordination model under this strategy, we should first analyze the sales situation of commodities in phase II and establish the expected profit function of commodities in phase II. On this basis, the total expected profit function is analyzed in combination with commodity sales in phase I. After analysis and development, the relationship between seller's order quantity function and the expected profit function of phase II is concave function, and when the order quantity of the expected profit function of phase II is the maximum, the first derivative of the order quantity is 0. Taking the optimal value of the order quantity based on the wholesale price contract under the decentralized decision-making mode as the proposition for verification and analysis, when the order quantity is lower than the optimal value of the order quantity determined by the centralized decision-making mode, it is found that the derivative of the order quantity shows a decreasing function relationship, indicating that there is a double marginal effect when the decentralized decision-making mode is adopted. That is to say, reducing the order quantity in sales cannot meet the requirements of supply chain coordination, so the supplier must encourage the seller to increase the order quantity appropriately through incentive measures.

2.3 Supply Chain Coordination and Decentralized Decision-Making Model Under the Repurchase Contract When Commodity Sales Price Drops

Under the decentralized strategy, newsboy model can also be used to coordinate the supply chain relationship based on repurchase contract. In this supply chain coordination model, the commodity supplier encourages the seller to order more commodities

by providing a repurchase contract, that is, the supplier will buy back the remaining commodities at the agreed buyback price after the completion of phase II of commodity sales, and the buyback price is between its production cost and the remaining residual value, $v < b < w$. Under this condition, the expected profit function of sellers in phase II should be constructed firstly, and then the total expected profit function should be analyzed in combination with the sales situation in phase I. At the same time, based on the repurchase contract, the realizable condition of supply chain coordination should be verified as a proposition. Combined with the model analysis results, the relationship between order quantity and expected profit function is concave function, and there is an optimal value of order quantity. When order quantity can meet the first derivative, its value is 0, and supply chain coordination can be realized. In addition, under the restriction of repurchase contract, in order to ensure that the repurchase parameters provided by suppliers are reasonable, the demand function should be deformed, and the different demand functions faced by sellers in different sales stages are analyzed respectively. According to the above analysis, the repurchase contract mode can effectively coordinate the supply chain under the condition of price reduction in phase II, and can promote the sellers to increase the order quantity. When constructing the supply chain coordination model, it is necessary to ensure that suppliers accurately understand the change of demand function, so as to ensure that the parameters in the repurchase contract model can meet the needs of supply chain coordination. As the demand function will also change when the commodity sales price changes, which increases the difficulty of supply chain coordination, the set value of parameter w in the repurchase contract model should be increased appropriately when the values of b and q are the same, or the set value of parameter b should be reduced appropriately when the values of w and q are the same, so as to adapt to the actual situation of supply chain coordination. When constructing the supply chain coordination model, it is necessary to fully consider the change of sellers' behavior caused by the change of commodity sales price, and adjust the set values of relevant model parameters accordingly, so as to ensure the profit distribution of supply chain is reasonable, so as to achieve the purpose of supply chain coordination.

2.4 Supply Chain Coordination Model Under Subsidized Repurchase Portfolio Contract with Falling Commodity Sales Price

While providing the repurchase contract can achieve coordination goods sales in two phase and phase II reduction manner mode of supply chain, but in the supply chain coordination need sellers can realize the demand information sharing between suppliers and sellers but in reality is often the past for the sale of goods of independent analysis, on this basis, it investigates and predicts sales information and statistical demand information, so demand information is exclusively owned by sellers [7]. In this context, such as adopting the decentralized decision making, vendors and suppliers in interests are relatively independent, so it is difficult to realize the demand information sharing, to coordinate the supply chain through buy-back contract way right now, so you have to build supply chain coordination model under the condition of asymmetric information, in order to take corresponding risk-sharing and profit allocation strategy, so as to maximize the profit of supply chain.

2.4.1 Construction of Supply Chain Coordination Model Based on Repurchase Contract Under the Condition of Information Asymmetry When Commodity Sales Price Drops

When constructing the supply chain coordination model under the condition of asymmetric information, because the sellers have a better understanding of the market demand information, when adopting the two-stage sales model, they often control the order quantity by the wholesale price contract before the first sales stage. After phase II of discounted sales, the remaining products will be sold back to the supplier at a price ($v < b < w$) lower than the wholesale price but still higher than the salvage value [6]. Since price-cutting is conducive to increasing the overall order quantity of goods, it is also beneficial to suppliers, so price-cutting in phase II should be encouraged by suppliers. However, the additional cost incurred in this case will be mainly borne by the seller. The extra cost mainly includes the profit loss caused by the reduction of commodity selling price. The two-stage selling strategy will lead to the increase of commodity selling cycle, which will objectively increase some costs of commodity inventory management, inventory holding and insurance expenses. In addition, when selling at a lower price, sellers generally need to invest in certain promotional costs. In order to realize risk sharing and ensure reasonable profit distribution of supply chain, suppliers need to give certain compensation to sellers. The compensation should be scientific and reasonable, so it is necessary to analyze and study the related factors and decision-making strategies through modeling.

2.4.2 Parameter Analysis of Supply Chain Coordination Model Under Combination Contract

In building supply chain coordination model combining the repurchase contracts and subsidies, should first consider seller before the start of the sales order situation, the supplier shall be in accordance with the commodity sales in phase I after the completion of the remaining number of subsidies to determine the value, then repurchase distributor sales in phase II after the completion of all the remaining goods. In modeling, m is used to represent the subsidy amount value of each unit of remaining goods after the completion of the first-stage sales of goods. At the same time, m value should not exceed the wholesale price, that is, $m < w$, so as to prevent sellers from directly benefiting from the price subsidy of suppliers [2]. In addition, sellers should be prevented from doing nothing in phase I of sales, and increase the sales of goods in phase II to obtain additional income by obtaining the amount of subsidies, that is, $w < p_2 + m < p_1$ [9].

2.4.3 Supply Chain Coordination Model Construction Under Portfolio Contract

When constructing the supply chain coordination model combining repo contract and subsidy, the expected profit function of sellers in phase II should be established first, and then the overall expected profit function of sellers in the two stages of sales should be established based on the sales situation of goods since phase I [4]. The analysis of combined contract model under certain coordination conditions shows that the relationship between expected profit function and order quantity is concave function, and there is an optimal value of order quantity. When the optimal value of order quantity can satisfy the

first derivative, its value is 0. It is analyzed that the combination of repurchase contract and subsidy can coordinate the supply chain and effectively solve the problem of risk sharing under the condition of asymmetric information.

3 Example Analysis of Supply Chain Coordination Model Under Repurchase Contract of Commodity Sales Price Change

In order to build the supply chain coordination model, professional computer software can be used to establish the algorithm model based on the parameters of the supply chain, so as to obtain the function relationship, so as to take the corresponding decision strategy. For example, if there is a new sale in a commodity supply chain, the sale price in phase I is 1200, but after entering phase II, the sale price is reduced to 900. According to the algorithm analysis results of demand information, the demand function of phase I should be $f_1(X_1) \sim N(1500, 40000)$, and the demand function of phase II should be $f_2(X_2) \sim N(4500, 250000)$, according to which the demand distribution function can be obtained by using professional computer analysis software. At the same time, big data technology can accurately grasp the changes of order quantity in the supply chain under the centralized decision-making strategy and the information related to the overall profit of the supply chain, and automatically complete the calculation of the profit percentage, and the big data software can automatically draw relevant charts, as shown in Fig. 1.

At the same time, professional data analysis software and big data technology can also be used to analyze the algorithm of the relationship between suppliers and sellers under the decentralized decision-making strategy based on the repurchase contract, and build the matrix relationship, as shown in Fig. 2.

In addition, through the data information model and related algorithms, we can also analyze the combination contract under the condition of information asymmetry and the supply chain coordination model under the decentralized decision-making strategy based on the wholesale price contract. The analysis shows that when the repurchase price of the new variety is between 701 and 764, i.e. $701 < b < 764$, and the supplier can hear the subsidy price between 200 and 225 (i.e. $200 < m < 225$), the supply chain can achieve coordination and increase the overall profit.

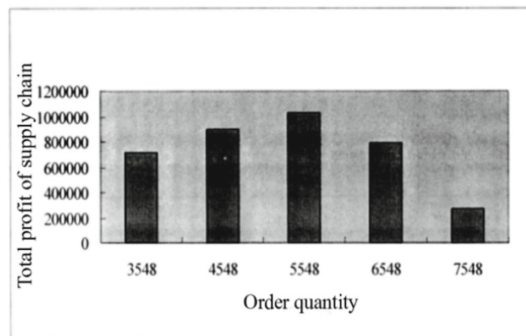


Fig. 1. Bar chart of the relationship between order quantity and supply chain profit. (Author self-drawn)

Supplier Seller	Wholesale price contract	Buyback contract
Wholesale price contract	(30870 , 893200)	(0 , 0)
Buyback contract	(0 , 0)	(π_{r1}^h, π_{s1}^h)

Fig. 2. Schematic diagram of vendor and supplier decision matrices. (Author self-drawn)

4 Conclusions

Repurchase contract is an important way to realize risk sharing between upstream and downstream members of the supply chain. It is mainly applicable to the sales of goods with strong demand uncertainty and short life cycle. This way is conducive to promoting the sales of popular goods and expanding the overall profit of the supply chain. In order to further optimize the repurchase contracts under the supply chain coordination mechanism, should actively adopt the modeling analysis methods such as the sales price change in different ways of decision-making and profit distribution are studied, in order to solve such problems as information asymmetry influence on supply chain coordination management, so as to achieve the aim of maximizing profits of supply chain, promote healthy development of China’s market competition.

References

1. Cai Xin, Sun Jingchun. (2020). Supply chain option coordination model considering bilateral risk preference [J]. Journal of management engineering,34(06):128–137.
2. Cai Xin, Sun Jingchun. (2019). Supply chain option contract coordination model with risk preference [J]. Industrial engineering and management,24(01):1–8+15.
3. Dai Jiansheng. (2020). Analysis of the impact of retailer’s capital constraint on coordination contract [J]. Chinese journal of management science,28(10):98–108.
4. Ji Xiang. (2018). Research on repurchase contract of three-level supply chain with demand influenced by price and sales effort [D]. Yanshan University.
5. Liu Lang, Wang Hui, Huang Donghong. (2022). Repurchase contracts for supplier risk avoidance under asymmetric cost of sales information [J/OL]. Chinese Journal of Management Science :1–10.
6. Li Yuanyuan. (2019). Research on Supply Chain Repurchase Contract Based on Loss Avoidance [D]. Yanshan University.
7. Saidjahon Hayrutdinov, Jian Ming, Wang Yonglong. (2019). Remanufacturing coordination model of supply chain with recycling quality affected by effort [J]. Integrated transportation,41(11):100–104.
8. Wang Ning, Hu Fei. (2020). Journal of capital normal university (natural science edition),41(04):1–6.
9. Wang Meiou. (2018). Research on supply chain repurchase contract under different expectation levels of sellers [D]. Shenyang University of Technology.
10. Xu Demin. (2020). Research on quality Control Model and Simulation of Multi-level closed-loop Supply Chain under Contract Coordination [D]. Shenyang University.

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